Installation, Operating & Maintenance Manual

DataFlo C Controller

CE

norbro

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The DataFlo C product complies with the following European directives and standards

Directives

89/36/EEC Electromagnetic Compatibility

73/23/EEC Low Voltage Directive

92/59/EEC General Product Safety

Standards

EN 50014: 1992 General Requirements

EN 60529: 1992 } Ingress protection
EN 60529: 1989

A separate Installation, Operating & Maintenance Manual exists for the DataFlo P and the Series 75 version of this product - contact Norbro for further details.

Contents

Installation, Operating & Maintenance Manual

1 GENERAL

The Norbro DataFlo products (DFC17 and DFP17) use the latest digital technology to give the customer the benefits of remote operation / calibration of the series 75 electric actuator. Utilising just two sizes of board, which can be used in any of the nine sizes of electric actuator, the DataFlo products can be selected to accept one of a possible seven input signals.
DFC17 - 120, 240 VAC & 24 VDC
DFP17 - 120, 240 VAC & 12, 24 VDC

1.1 STORING THE DATAFLO PRODUCTS PRIOR TO USE

Prior to use, all electrical products should be stored in areas that do not exceed 85% relative humidity and which have a temperature range of between 4.5 - 48.5°C. Do not store in areas where acidic, alkali fumes or radiation is present or within 50 feet of any source of ozone.

1.2 TEMPERATURE CONSIDERATIONS

For the DataFlo Products to operate between -17°C and 73°C, the maximum ambient temperature within the series 75 electric actuator must not exceed 46°C. Both products use solid state electronic equipment, and using the actuator above the stated operating temperatures could cause the equipment to fail prematurely. Generally the equipment will continue to operate correctly as soon as the rated operating temperatures are reached.
Low temperature and high humidity applications should use the heater / thermostat option within the actuator housing.

1.3 CIRCUIT BOARD LAYOUT

There are four setpoint and three standard process signal inputs for each DataFlo product in each of their respective voltages. Figures 1 & 2 (Pages 9 &10) show the location of the major circuit board components and the terminal strip.
NOTE: Due to the protective coating applied to the circuit board, customer alterations are not recommended.

Three simple Light Emitting Diodes (LEDs) are used to give visual direction indication and activated alarm conditions. The two direction LEDs, LD1 and LD2, are located just to the left of the liquid crystal display (LCD) and the alarm condition LED, LD3, is located just to the right of the actuator shaft.

There are three simple push-button switches on both DataFlo products which are used to configure and calibrate and tune the digital positioner or controller. The three push-button switches are **SEL** (select), **UP** (scroll up) and **DN** (scroll down).

2 INSTALLATION

If the actuator was ordered with either of the DataFlo products fitted, then turn to Section 4 Page 8 (DFC17).

It is recommended that the following tools are used:

¼" Spanner or nut runner
⅛" Flat bladed screwdriver
1⁄16" Allen key
Needle nose pliers
A multimeter to measure the resistance / voltage
A milliampere source / generator
VAC or VDC power supply

Prior to installing the DataFlo products, it is important to check the rotation of the standard electric actuator.

AC ACTUATOR

Cycle the actuator to the fully closed position (CW) by connecting the AC electrical supply to terminals 1 and 4 (neutral in 1 and live in 4), if the actuator was received in the open position.

With the electric supply disconnected connect the live wire to terminal 3.

Re-connect the electrical supply and the actuator will cycle in the CCW direction.

If the actuator fails to stop or over travels in either direction, the cams require adjustment, release the set screw in the appropriate cam and adjust so that the limit switch actuates between 1 to 3 degrees beyond the closed / open position. Retighten the set screw in the cam when the correct rotation has been obtained.

DC ACTUATOR

Cycle the actuator to the fully closed position (CW) by connecting the electrical supply to terminals 1 and 4 (negative in 1 and positive in 4) if the actuator was received in the open position.

To cycle the actuator to the fully open position (CCW), disconnect the electrical supply and connect the negative wire to terminal 3 and the positive wire to terminal 1.

If the actuator fails to stop or over travels in either direction, the cams require adjustment, release the set screw in the appropriate cam and adjust so that the limit switch actuates between 1 to 3 degrees beyond the closed / open position. Retighten the set screw in the cam when the correct rotation has been obtained.

With the actuator in the fully open position (CCW), release cam number 1 (lowest on the actuator shaft) by unscrewing the set screw.

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2.1 FEEDBACK POTENTIOMETER ASSEMBLY

Remove indicator knob and the cover retaining screws. Carefully remove the cover.

2.1.1 SIZE 10 - 23 ACTUATOR FEEDBACK POTENTIOMETER ASSEMBLY

To assemble the feedback potentiometer to the mounting bracket, remove the small spur gear and locate the potentiometer shaft through the large hole so that the body of the potentiometer is directly above the bracket mounting holes.

Rotate the potentiometer body so that the orientation pin locates into the small hole.

Place the lock washer followed by the nut onto the potentiometer housing and tighten.

NOTE: Do not over tighten as the plastic thread may strip.

Place the small spur gear onto the potentiometer shaft so that the plastic gear is flush with the end of the shaft. Do not tighten.

2.1.2 SIZE 25 AND 30 ACTUATOR FEEDBACK POTENTIOMETER ASSEMBLY

To assemble the feedback potentiometer to the mounting bracket, remove the small spur gear and locate the potentiometer shaft through the large hole so that the potentiometer shaft is directly above the bracket mounting holes.

Rotate the potentiometer body so that the orientation pin locates into the small hole.

Place the lock washer followed by the nut onto the potentiometer housing and tighten.

NOTE: Do not over tighten as the plastic thread may strip.

Place the small spur gear onto the potentiometer shaft so that the plastic gear is flush with the end of the shaft. Do not tighten.

2.1.3 INSTALLATION OF THE POTENTIOMETER ASSEMBLY (sizes 10-23)

Remove the two motor module mounting screws that are located furthest away from the actuator shaft taking care not to damage any secured wires.

If required, remove the cable ties that secure the wires to gain access to the specific mounting screws.

Line up the potentiometer shaft with the actuator shaft and secure the bracket with the two motor module mounting screws. Secure all motor wires with cable ties if they were removed.

2.1.4 INSTALLATION OF THE POTENTIOMETER ASSEMBLY (SIZES 25 AND 30)

The potentiometer mounting holes can be found between the terminal strip and the actuator shaft. Position the potentiometer bracket, with the wires facing away from the actuator shaft, and align with the actuator shaft before securing with the two screws provided.

TERMINAL STRIP	WIRE COLOUR
TB-1 Terminal P	Purple
TB-1 Terminal W/B	White / black (or white only)
TB-1 Terminal G	Green

2.2 FEEDBACK POTENTIOMETER ADJUSTMENT

For all sizes of actuators using potentiometers, place the large face gear over the actuator shaft leading with the gear teeth. Locate the appropriate number of circlips, (one for 10-23 or two for 25/30) over the face gear seating the clips square on the small posts. Lower the face gear and adjust the small spur gear so that 1.5 to 2.0mm of engagement is achieved. Secure the small spur gear by tightening the set screw.

NOTE: The face gear was designed as a friction fit to the actuator shaft. For positive shaft position wipe all grease from actuator shaft prior to fitting the face gear.

2.3 FEEDBACK POTENTIOMETER CALIBRATION

To calibrate the feedback potentiometer the actuator must be in either the fully open or fully closed position. With all electrical supplies to the actuator switched off and the actuator in the fully closed position, connect an Ohmmeter across the purple and white / black wires. Rotate the face gear, thus rotating the potentiometer shaft, until the Ohmmeter reads approximately 80 to 90 Ohms.

NOTE: If the actuator was in the fully open position the Ohmmeter should be connected across the green and white / black wires.

Connect the electrical supply and cycle the actuator to the opposite position so that the resistance can be measured.

With the actuator now in the open position, switch off the electrical supply and measure the resistance of the feedback potentiometer across the purple and white / black wires. If the actuator was cycled from the open position and is now in the closed position, measure across the green and white / black wires.

In either case the Ohmmeter reading should be greater than 700 Ohms. If this is not the case then cycle the actuator back to the original position and recheck the resistance.

IMPORTANT: The feedback potentiometer has now been calibrated for one 90° quadrant. If for any reason the actuator output shaft should rotate to another 90° quadrant or multiple 360° rotation then the potentiometer will no longer be in calibration and must be recalibrated.

To indicate that a potentiometer has been installed, fit the potentiometer caution label to the outside of the actuator cover.

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3 MOUNTING THE CIRCUIT BOARD

3.1 MOUNTING THE CIRCUIT BOARD (size 10 - 23 AC actuators)

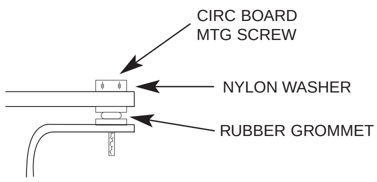
Prior to assembling the mounting brackets to either the motors or spacers, orientate the actuator so that the terminal strip is forward and the actuator shaft is vertical. The longer mounting bracket is to be fiited on the right hand motor / spacers, and the shorter bracket, similar in design, is to be fitted on the left hand motor / spacer.

NOTE: If fitting the mounting bracket(s) to a motor(s), ensure that the mounting screws are replaced in the same holes. This will eliminate any possibility of damaging the self tapping screws.

After tightening the motor / spacer screws, firmly tap the motor stator with a plastic faced mallet to align the motor bearings.

Fit the smallest mounting bracket to the left hand limit switch using the nearest screw to the terminal strip. Tighten the limit switch mounting screw with the bracket square to the terminal strip. Do not over tighten.

Slide four of the six rubber grommets into the insulation board mounting holes and orientate so that the holes line up with the circuit board holes. Place a nylon washer over each of the six screws and locate through the circuit and insulation board. Screw five of the six screws into the mounting brackets located on either the motors or spacers. Locate the sixth rubber grommet between the small bracket and the circuit board and secure using the remaining screw, this rubber grommet must be fitted as shown in fig 2.



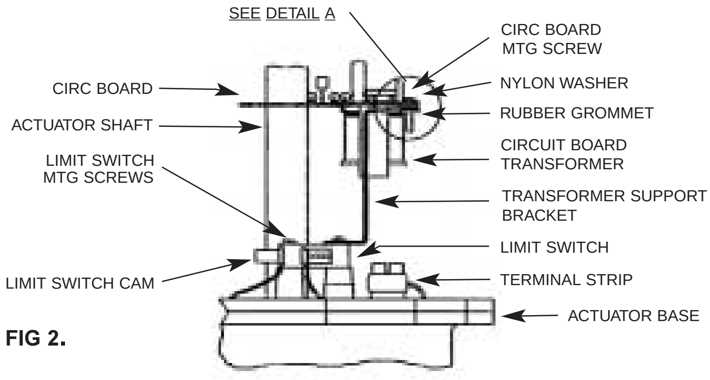


FIG 2.

Referring to Page 11 (Figures 4 or 5), unscrew the terminal screws which will be used during this installation. Ensure that all wiring is secure and is away from all moving / rotating parts.

Tighten down the six board mounting screws until the rubber grommets are approximately half compressed. Route the three potentiometer wires through the small hole to the right of the actuator shaft and terminate into TB-1 found on the circuit board. See Table on Page 5.

3.2 MOUNTING THE CIRCUIT BOARD (Sizes 25 & 30 AC actuators)

Prior to assembling the mounting brackets to the motor support plate, orientate the actuator so that the terminal strip is forward and the actuator shaft is vertical.

Fit the mounting bracket to the left hand side of the motor support plate so that the bracket mounting holes are facing the actuator shaft.

Slide four of the five rubber grommets into the insulation board mounting holes and orientate so that the holes line up with the circuit board holes. Place a nylon washer over each of the five screws and locate through the circuit and insulation board. Screw all five screws through the circuit and insulation board into the mounting bracket.

Referring to Page 11 Figure 4, (DC not available in this size) unscrew the terminal screws which will be used during this installation. Ensure that all wiring is secure and is away from all moving / rotating parts.

Tighten down the circuit board mounting screws until the rubber grommets are approximately half compressed.Route the three potentiometer wires through the small hole to the right of the actuator shaft and terminate into TB-1 found on the circuit board. See Table on Page 5.

3.3 MOUNTING THE CIRCUIT BOARD (size 10 - 23 DC actuators)

Prior to assembling the mounting brackets to either the motors or spacers, pre-tap the circuit board mounting holes with the short screws. Remove the two outer motor screws and mount the brackets and the appropriately sized spacers on the motor holes using the existing screws.

NOTE: The correct length of mounting spacer is essential and is determined by the size of actuator.

Sizes 10 and 12 actuators use the two shortest spacers on the motor side and the two intermediate spacers for the remaining side. All four spacers use the shorter mounting screws.

Sizes 20 and 22 actuators use four short spacers and the four shorter mounting screws.

Size 23 actuators spacers use the four spacers and screws provided.

Orientate the actuator so that the terminal strip is forward and the actuator shaft is vertical. The longer mounting bracket is to be fitted on the right hand motor / spacers, and the shorter bracket, similar in design, is to be fitted on the left hand motor / spacer.

NOTE: If fitting the mounting bracket to a motor, ensure that the mounting screws are replaced in the same holes. This will eliminate any possibility of damaging the self tapping screws.

After tightening the motor / spacer screws, firmly tap the motor stator with a platic faced mallet to align the motor bearings.

Fit the smallest mounting bracket to the left hand limit switch using the nearest screw to the terminal strip. Tighten the limit switch mounting screw with the bracket square to the terminal strip. Do not over tighten.

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Slide four of the six rubber grommets into the insulation board mounting holes and orientate so that the holes line up with the circuit board holes. Place a nylon washer over each of the six screws and locate through the circuit and insulation board. Screw five of the six screws into the mounting brackets located on either the motors or spacers. Locate the small rubber grommet between the small bracket and the circuit board and secure using the remaining screw. For size 23, replace the rubber grommet with the plastic spacer provided.

Referring to Page 11 (Figure 5), unscrew the terminal screw which will be used during this installation. Ensure that all wiring is secure and is away from all moving / rotating parts.

Route the three potentiometer wires through the small hole to the right of the actuator shaft and terminate into TB-1 found on the circuit board.
See Table on Page 5.

4 WIRING

WARNING: Actuators which have either 120 or 240 VAC indicated on the product label use mains power. Switch off electric supply prior to installation and adjustment. This must be carried out only by a qualified electrician.

Worcester Controls do not accept any responsibility for problems that may arise from incorrect installation of this product.

All signal input circuit wiring, regardless of length, must be supplied through shielded wire. All shielded wiring must be earther to the actuator housing at one end only. Earthing both ends of the shielded wire could eliminate the shielded benefits.

4.1 DFC17 240AC WIRING (size 10 - 30)

For this voltage the two limit switches are used to switch off the opto-couplers U1 and U2 outputs at each end of stroke rather than directly turning off the motor. By doing this it protects the triacs Q3 and Q4 by ensuring that they are switched off by their gate circuit and do not shut off whilst full power is supplied.

Replace the original Grey and Blue actuators wires with those provided, noting which capacitor terminal they were removed from. Fit the capacitor wires to terminals 3 and 4. Grey wire to terminal number 3 and Blue to number 4.

The two black and red wires from the DFC17 are to be terminated to the following switches. The four wires must be routed from behind the terminal strip starting from the left

The black wires are to be connected to switch number 1 (terminals common and normally closed). Switch number 1 is the lower right hand switch. The Red wires are to be connected to switch number 2 (terminals normally closed and common) lower left hand switch.

Fig. 1

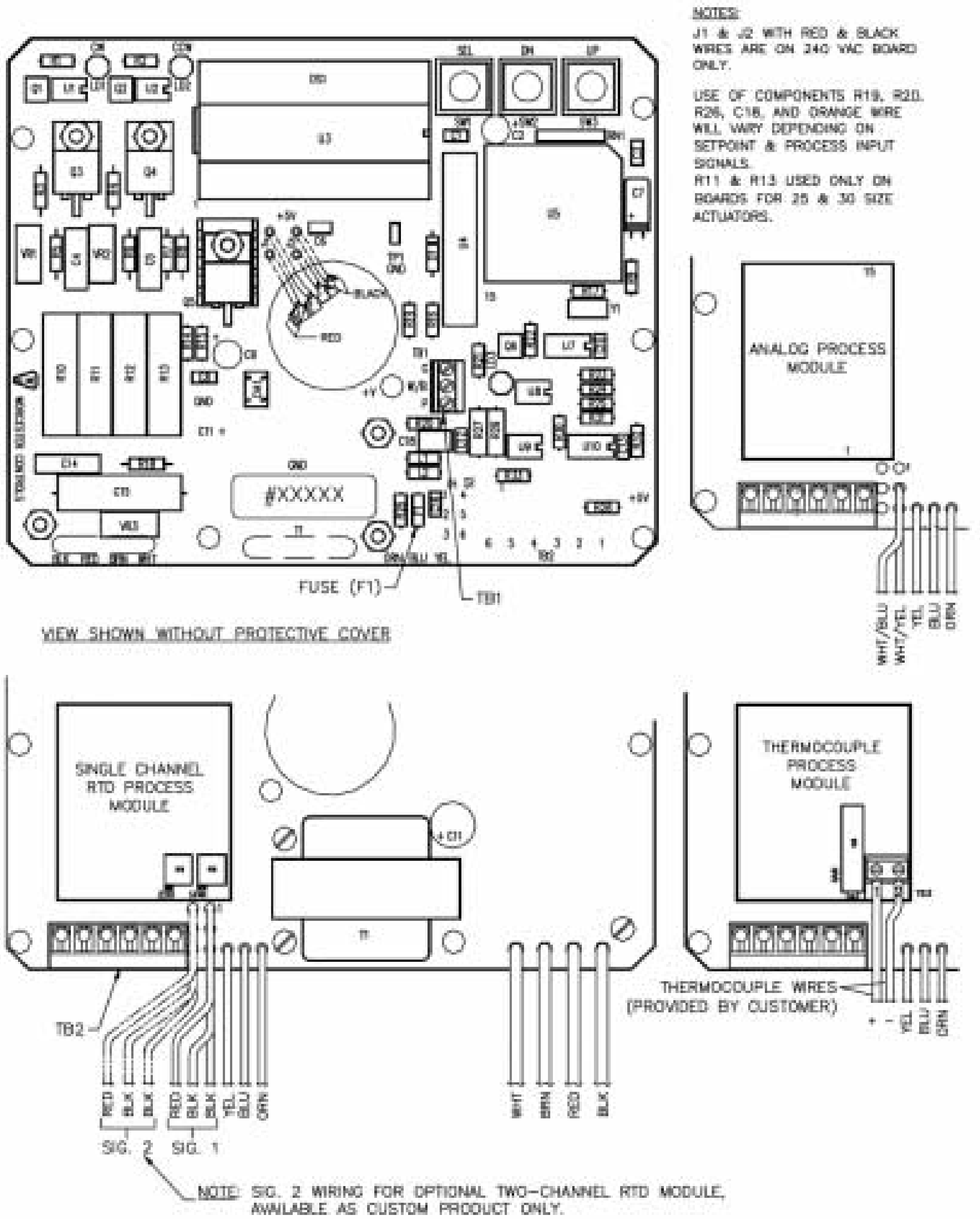

NOTES:
J1 & J2 WITH RED & BLACK WIRES ARE ON 240 VAC BOARD ONLY.
USE OF COMPONENTS R19, R20, R26, C18, AND ORANGE WIRE WILL VARY DEPENDING ON SETPOINT & PROCESS INPUT SIGNALS.
R11 & R13 USED ONLY ON BOARDS FOR 25 & 30 SIZE ACTUATORS.
#XXXXX
FUSE (F1)
TB1
VIEW SHOWN WITHOUT PROTECTIVE COVER
ANALOG PROCESS MODULE
WHT/BLU
WHT/YEL
YEL
BLU
ORN
SINGLE CHANNEL RTD PROCESS MODULE
TB2
RED
BLK
BLK
RED
BLK
BLK
YEL
BLU
ORN
SIG. 2
SIG. 1
WHT
BRN
RED
BLK
THERMOCOUPLE PROCESS MODULE
THERMOCOUPLE WIRES (PROVIDED BY CUSTOMER)
+
-
YEL
BLU
ORN
NOTE: SIG. 2 WIRING FOR OPTIONAL TWO-CHANNEL RTD MODULE, AVAILABLE AS CUSTOM PRODUCT ONLY.

Fig. 2

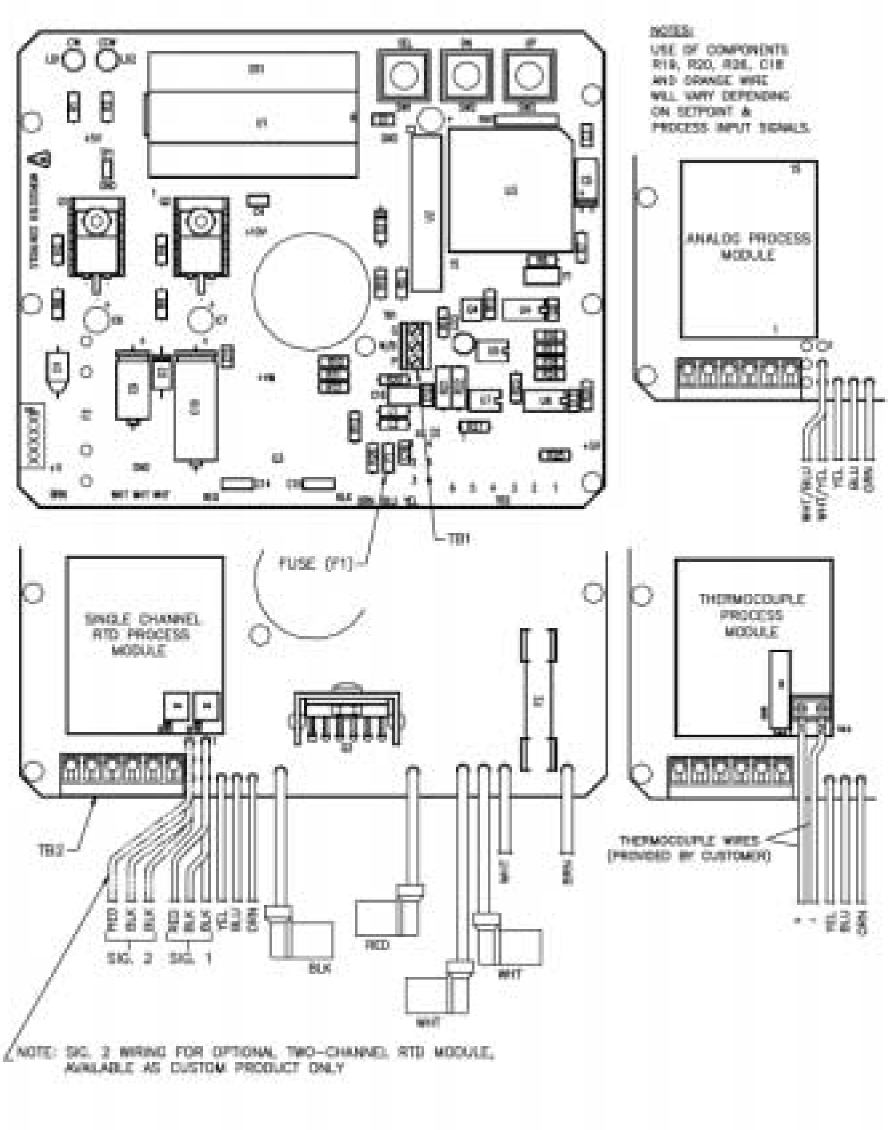
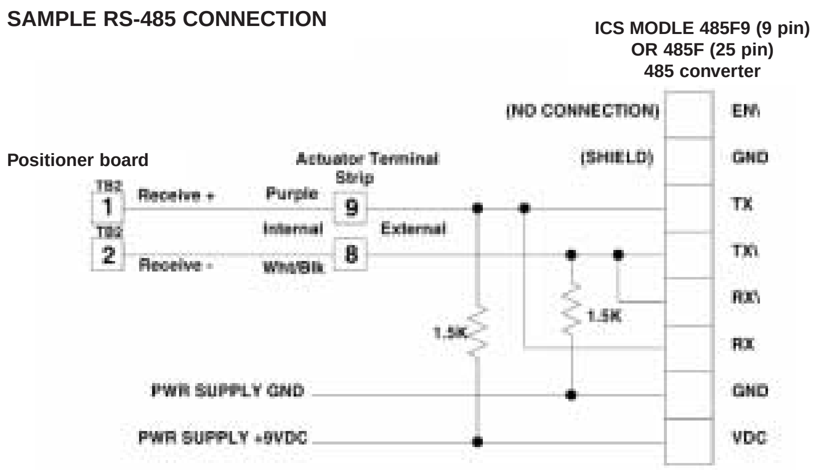


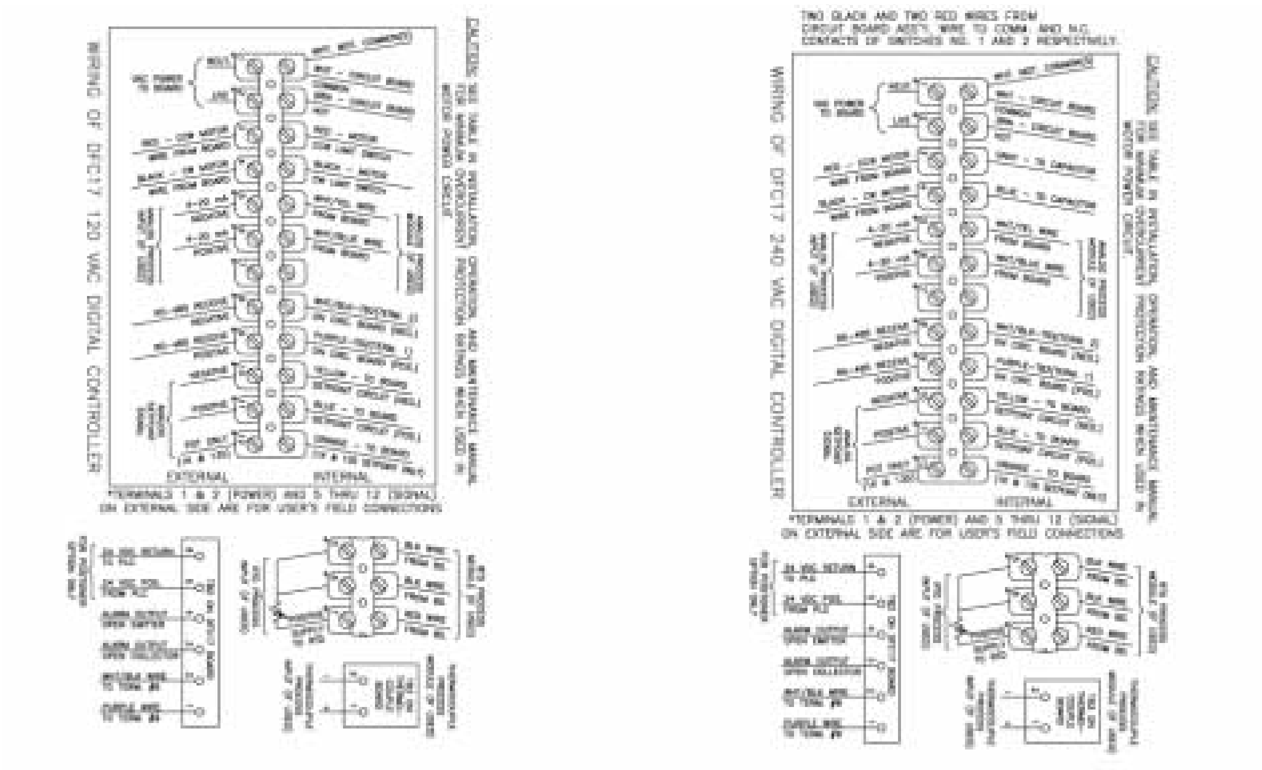
Fig. 3



NOTE: If you are not using the RS-485 converter as shown in Figure 3, then refer to the documentation that came with your converter for proper connections.

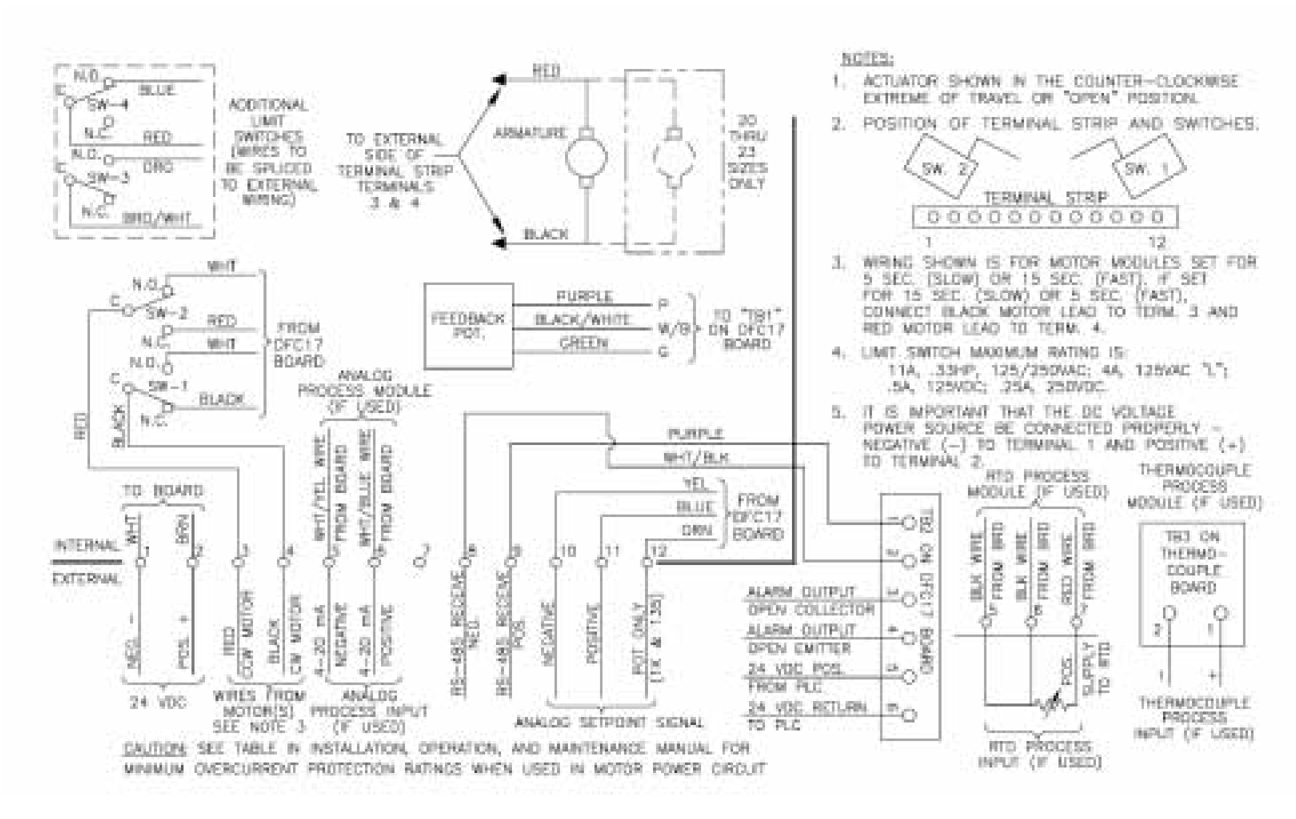
120 & 240 VAC DFC17 CIRCUIT BOARD WIRING

Fig. 4



24 VDC DFC17 CIRCUIT BOARD WIRING

Fig. 5



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4.2 DFC17 120VAC WIRING (size 10 - 30)

For the 120 VAC board only, disconnect the Yellow wire from the normally open contact of switch number 1 and remove from terminal number 5. Also disconnect the Brown wire from the normally open contact of switch number 2 and remove from terminal number 6.

All wires should be secured and must be kept clear of moving and rotating parts.

4.3 INSTALLATION OF OPTIONAL 4-20mA POSITION INDICATOR

For units with a 4-20 mA position indicator option installed, the red and black wires from the position indicator board will have to be spliced directly to the external positive and negative output (meter) wires respectively.

NOTE: Before wiring, calibrate indicator board per the following paragraph.

To obtain an accurate 4-20 mA output, the indicator board output requires calibrating prior to wiring red & black wires. Using an ammeter connected to the red & black wires of the indicator board, adjust the two potentiometers R4 and R5 on the board. With the actuator in the closed position (0%), adjust R5 potentiometer (adjacent to the number “4” etched on the circuit board and closest to terminal block) to obtain a 4 mA reading on the ammeter. Cycle the actuator to the open position (100%) and adjust R4 potentiometer (adjacent to the number “20” etched on the circuit board) to obtain a 20mA reading. As the adjustment of each potentiometer affects the other, repeat the procedure several times to obtain the correct output.

NOTE: If a dual potentiometer option is installed, the “B” potentiometer leads will have to be wired directly to external device. The “A” potentiometer leads are factory connected to the terminal block (TB1) on the Digital Controller Board. Also, note that the potentiometer has a voltage limit of 30 volts maximum.

IMPORTANT: Looking from above the module, the pin with a square soldered area has been clipped off. For correct installation this pin must be aligned with the filled socket marked GND.

4.4 ACTUATOR POWER

The electrical supply to the actuator and controller board should be connected to terminals 1 and 2. The AC neutral / common supply, or the DC negative supply, should be terminated in terminal 1. The AC live or DC positive supply should be terminated in terminal 2.

Both the AC supplies 120 and 240 VAC have a voltage tolerance. The 120 VAC

ACTUATOR SIZE	VOLTAGE	FUSE RATING
10 to 23	120 VAC	5A
25 and 30	120 VAC	10A
10 to 23	240 VAC	3A
25 and 30	240 VAC	5A
10 to 23	24 VDC	5A

nominal voltage board has a minimum of 110 and a maximum of 130 volts. However, the 240 VAC nominal voltage board has a minimum of 220 and a maximum of 250 volts.

The table on page 12 details the size of actuator, voltage and the minimum fuse rating for overcurrent protection.

5 INPUT SIGNAL CONNECTIONS

The 4-20 mA Setpoint signal input circuit of both the AC and DC Digital Controller board are protected with a 62 mA fuse (F1). The fuse is used to protect the input circuit from an excessively high voltage. The fuse used in the input circuit is a Littlefuse PICO II very fast acting fuse.All DC Digital Controller boards also use a standard 1¼", 250 volt, 3 amp fuse (F2) to protect the circuit board and the power source in case of a fault in the DC motor driver integrated circuit on the circuit board.

Contact Invensys Flow Control (UK) for replacement fuses.

CAUTION: It is important that the DC voltage power source be connected properly to the actuator's terminal strip. Terminal 1 should have the negative wire connected to it and terminal 2 should have the positive wire connected to it.

5.1 SETPOINT AND PROCESS SIGNAL INPUT OPTIONS

4-20 mA	Approx. 1000 Ohms
1-5 mA	Approx. 220 Ohms
10-50 mA	Approx. 100 Ohms
0-5 vdc	Approx. 800 Ohms
0-10 vdc	Approx. 1100 Ohms
135 Ohm pot	
1000 Ohm pot	

5.2 MILLIAMPERE INPUT SIGNAL (DFC17-1, DFC17-4 DFC17-10)

For a milliampere setpoint signal input, the more positive or “High” signal lead should connect to actuator terminal 11. The less positive or “Common” lead should connect to actuator terminal 10. [Terminal 10 is (-), Terminal 11 is (+).]

The Controller is available for use with the following milliampere signals: 1 to 5, 4 to 20, and 10 to 50 milliamperes. The Controller board is factory set for one of the 3 milliampere signal ranges and field changes are not advised.

Section 5.1 (above) gives the nominal resistance load, which the Controller presents to the control circuit for the three mA signal ranges.

Comparison of resistance measurements made at terminals 10 and 11 (on the yellow and blue wires from the circuit board) against the resistances shown in section 5.1 provides a quick way to determine the milliampere range for which a particular board is set. If fuse F1 is blown, an open circuit will be indicated.

NOTE: If the circuit board has an orange wire (See Page 9 Figure 1) attached to it, the board is set up for a Potentiometer input signal. See Page 14 Section 5.4.

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5.3 DC INPUT SIGNAL (DFC175V, DFC17XV)

For a voltage setpoint input signal, the more positive or “High” signal lead should connect to terminal 11. The less positive or “Common” lead should connect to terminal 10. [Terminal 10 is (-), Terminal 11 is (+).]

The controller is available for use with the following direct voltage setpoint input signals: 0 to 5 VDC and 0 to 10 VDC. The controller board is factory set for one of these two signal ranges and field changes are not advised.

Page 13 Section 5.1 gives the nominal resistance load which the controller presents to the control circuit for the two signal ranges.

5.4 POTENTIOMETER INPUT SIGNAL (DFC1713, DFC171K)

NOTE: The input signal potentiometer is not the feedback potentiometer, but is an additional potentiometer provided with the controller, and externally located by the end user. The acceptable potentiometer values are 135 Ohm for the DFC1713 board and 1000 Ohms for the DFC171K board.

For a potentiometer setpoint input signal, the usual connections (shown on Pages 10 & 11 Figures 3 - 5) with a “low” setpoint command being generated when the potentiometer is rotated to its full CCW position and a “high” setpoint command when it is in the full CW position.

If the setpoint command signal is derived from other than a rotary pot, it is only necessary to keep in mind that a “low” (full CCW) setpoint signal is called for when the command potentiometer presents the least resistance between terminals 10 and 11 and the most resistance between terminals 11 and 12. A “high” (full CW) setpoint signal would be the reverse condition; the least resistance between terminals 11 and 12 and the most resistance between terminals 10 and 11.

If the “setpoint command” potentiometer is reasonably linear, the setpoint will be approximately 50% when the potentiometer shaft is halfway through its travel.

6 OPERATION OF THE DFC17

Refer to RS485 Communications software diskette included with controller for more information.

The DFC17 Controller is capable of being operated in several modes. The normal mode of operation is the RUN mode. Below is a list of the various modes and the key sequences necessary to enter each of them and the function of each of the parameters within that mode:

6.1 RUN MODE

This is the normal operating mode.

While in the Run Mode momentarily pressing:

SEL Toggles between alternating name/value and continuous value display.

UP Shows the next parameter.

DN Shows the previous parameter.

DISPLAY	DESCRIPTION	UNITS
Pr1	Process #1 signal value	Engineering
Pr2	Process #2 signal value	Engineering
Pr12	Average of process #1 and process #2 signal values	Engineering
SET	Setpoint value. Only one of the following will be displayed: SEtA – analog setpoint; SEtP – digital setpoint; SEtL – local manual setpoint	Engineering
PtEr	Proportional term value	NONE
itEr	Integral term value	NONE
dtEr	Derivative term value	NONE
ALr	Alarm. Alarm shown is highest priority. See Table on Page 16	N/A
POS	Valve position	Percent
CYCn	Number of cycles	Times 1000 cycles
PHi	Highest recorded process value	Engineering
PLo	Lowest recorded process value	Engineering

6.2 MODE CHANGE KEY SEQUENCE

PRESS KEY(S) FOR 3 SECONDS	MODE ENTERED
SEL	Program Mode
SEL + DN	Calibration Mode
SEL + UP	Manual Setpoint Mode
SEL + DN + UP	Manual Position Mode (gives access to Auto Tuning)

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6.3 ALARM DISPLAYS

DISPLAY	DESCRIPTION
PrHI	Process high limit alarm
PrLo	Process low limit alarm
HI	Shaft upper position alarm
Lo	Shaft lower position alarm
SHFt	Invalid shaft position alarm
Pro	Invalid process value alarm
SEt	Invalid setpoint value alarm
thEr	Motor driver circuit thermal warning alarm (DC motors only)

Pressing **SEL** while the alarm condition is alternating on the display will freeze the display with the highest priority alarm showing. Then pressing **SEL** again will attempt to reset the alarm display. If the alarm condition(s) still exist after pressing **SEL**, the display will continue to show the alarm(s).

6.4 CALIBRATION MODE

Press **SEL** + **DN** keys for 3 seconds will enter the calibration mode **CAL** from the run mode. A security code may be required for entry to the calibration mode. If one is required, it is checked and entered using the instructions below and for editing a numeric value as described on Page 25 Section 6.5.2.

Simultaneously press and hold the **SEL** + **DN** keys for 3 seconds, **CAL** will be displayed for 2 seconds and the security code will be checked. If the required security code is not zero (0000), the display will begin alternating between **CodE** and **0000**. If the required security code is zero, it will not need to be entered, i.e., it will be bypassed and display will automatically flash **SEtL**.
See Page 17 Section 6.4.2.

Enter the security code, if necessary, as follows. (If the code is forgotten, the special number **4800** can be used to gain entry).

Quick tap **SEL** key once. First 0 will flash. Quickly tap the **UP** key until you reach code number. Quick tap the **DN** key once. The second 0 will flash Quick tap the **UP** key until the next code number is reached. Continue this procedure as needed for the remaining code numbers. Quick tap **SEL** to accept code.

Quickly tap the **DN** key. The display now flashes between **SEtL** and a value.

Press **SEL** key for 2 seconds to return to the Run Mode.

For the table below, pressing:

SEL To sequence through the calibration parameters.

SEL+ UP To enable/start calibration of the selected parameter.

6.4.1 CALIBRATION MODE MENU

DISPLAY	DESCRIPTION	ACCEPTABLE RANGE
SEtL	Setpoint lower limit signal value	Less than 1 volt
SEtU	Setpoint upper limit signal value	Between 3.800V & 5.000V
PoC	Shaft position feedback value at full clockwise position	Between .200V & 400V
PoCC	Shaft position feedback value at full counter-clockwise position	Greater than 3.0V
PrIL	Process #1 signal lower limit value	Unique to process
PrIu	Process #1 signal upper limit value	Unique to process
Pr2L	Process #2 signal lower limit value	Unique to process
Pr2U	Process #2 signal upper limit value	Unique to process
CYt	Cycle time measurement	Dependent on actuator

6.4.2 KEY SEQUENCES FOR CALIBRATING SETPOINT LOWER LIMIT

Press **DN** to select the lower setpoint parameter SEtL (only if the security code was entered).

Press **SEL** + **UP** to begin calibrating the parameter.

Attach an accurate current source to the setpoint signal input and adjust the source to produce a 4 mA signal. The voltage reading on the display should be less than 1 volt.

Press **SEL** to accept the value shown and return to the calibration menu.

6.4.3 KEY SEQUENCES FOR CALIBRATING SETPOINT UPPER LIMIT

Press **DN** to select the upper setpoint parameter **SEtU**

Press **SET** + **UP** to begin calibrating the parameter.

Attach an accurate current source to the setpoint signal input and adjust the source to produce a 20 mA signal. The voltage reading on the display should be between 3.800 and 5.000 volts.

Press **SEL** to accept the value shown and return to the calibration menu.

6.4.4 KEY SEQUENCES FOR CALIBRATING CLOCKWISE POSITION

Press **DN** to select the clockwise setpoint parameter **PoC**

Press **SEL** + **UP** to begin calibrating the parameter.

1) Use either the **UP** or **DN** switches to manually rotate the actuator to its full clockwise (CW) position.
2) With the actuator in the full CW position, adjust the feedback potentiometer by rotating the face gear with your fingers for a reading between 0.2 and 0.4 volts.

Press **SEL** to accept the value shown and return to the calibration menu.

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6.4.5 KEY SEQUENCES FOR CALIBRATING COUNTER-CLOCKWISE POSITION

Press **DN** to select the counter-clockwise setpoint parameter **PoCC.**

Press **SEL + UP** to begin calibrating the parameter.

1) Use either the **UP** or **DN** switches to manually rotate the actuator to its full counter-clockwise (CCW) position.

2) With the actuator in the full CCW position, the voltage reading on the display should be greater than 3.000 volts. If not, re-check **PoC**. If it is correct and the **PoCC** reading is still not correct, contact Worcester Controls.

Press **SEL** to accept the value shown and return to the calibration menu.

6.4.6 KEY SEQUENCES FOR CALIBRATING ANALOGUE PROCESS #1 LOWER INPUT SIGNAL

This procedure should be followed only if an analogue process module is used.

Press **DN** to select the lower input parameter **PrIL.**

Press **SEL** + **UP** to begin calibrating the parameter.

Connect an accurate current source to the process input terminals and set a current of 4.0 mA. The voltage reading on the display should be less than 1 volt.

Press **SEL** to accept the value shown and return to the calibration menu.

6.4.7 KEY SEQUENCES FOR CALIBRATING ANALOGUE PROCESS #1 UPPER INPUT SIGNAL

This procedure should be followed only if an analogue process module is used.

Press **DN** to select the upper input parameter **PrIU**

Press **SEL** + **UP** to begin calibrating the parameter.

Connect an accurate current source to the process input and set a current of 20 mA. The voltage reading on the display should be greater than 3.000 volts

Press **SEL** to accept the value shown and return to the calibration menu.

6.4.8 KEY SEQUENCES FOR CALIBRATING SINGLE CHANNEL RTD PROCESS MODULE

This procedure should be followed only if a single channel RTD process module is used. With this type of process module, the connected 100 Ohm platinum RTD develops a voltage representing the temperature of the process. RTDs can cover a very wide temperature range. The RTD module however allows a narrower temperature range to be used. This is useful for applications that need higher resolution and do not need a wide range.

The purpose of this procedure is to specify the temperature units, temperature range, and to record the actual voltage values at the lower and upper process limits. This procedure involves adjusting components on the RTD module. This procedure is entered by selecting either the **Pr1L** or **Pr1U** parameter for calibration. When either of these parameters are selected for calibration, the controller starts the following calibration sequence. At any time in the menu, the user can press the **SEL** key to return to the calibration menu.

Any one step in the calibration procedure can be performed without performing the others. However, it is recommended to perform all the calibration steps if any one item is changed.

Calibrating the RTD module circuitry involves adjusting the span and zero potentiometers on the module to achieve a good voltage swing for the temperature range selected. When adjustments have been properly completed, the calibration routine will use the calibrated analog voltages to create a linearization table.

The table on Page 20 shows the calibration steps and the procedures required to complete the steps. It is recommended to perform all the calibration steps if any one item is changed. Any time a potentiometer is adjusted, both the **AdcL** and **AdcU** procedures must be performed again.

Press the **DN** key until the **Pr1L** parameter appears. On that display, press the **SEL** and **UP** keys simultaneously to enter the RTD calibration menus shown below.

On the menus below, use the **DN** key to move from one parameter to the next one in sequence. When calibration is completed, press and hold the **SEL** key for 3 seconds to return to the main Calibration Mode menu (the **Pr1L** parameter). Release and then press the **SEL** key again for 3 seconds to return to the Run Mode.

NOTE: When the RTD temperature units are changed, the upper range limit will be changed to the default maximum range shown below.

TEMPERATURE UNITS	DEFAULT (MAX.) TEMPERATURE RANGE
°C	-200 to +800
°F	-300 to +999

NOTE: Maximum allowable span is 800°C, e.g., -200°C to +600°C or 0°C to 800°C. Minimum span is 50°C. Span must be set in 50°C increments.

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The procedure for calibrating the module will involve adjusting the span and zero potentiometers on the RTD module. Since there can be some interaction between the two pots, the lower and upper limits are adjusted in the step for the upper limit. The lower limit procedure is used only to record the lower limit voltage and no adjustments should be made in that step.

When adjusting the potentiometers for the upper and lower limit, the voltage range should be as great as possible for the best resolution. However, some guard band area should be left for the possibility of temperatures slightly outside the specified range. For example, if the lower limit voltage was 0.100 volts and the upper limit voltage was 4.900 volts, that would give very good resolution, but would not allow much room for temps outside of the specified limits. A span of 0.500 and 4.500 volts might be better.

STEP DISPLAY	PROCEDURE
UniT	Press **SEL** and **UP** to change the temperature units. When **SEL** and **UP** are pressed, the units will begin flashing. Pressing the **UP** or **DOWN** keys will change the units between degrees Fahrenheit and Celsius. When the correct units are flashing, press **SEL** to lock in the selection.
rn9U	Press **SEL** and **UP** to change the temperature range upper limit. When **SEL** and **UP** are pressed, the upper limit will begin flashing. Pressing the **UP** or **DOWN** keys will change the upper limit to another value. When the correct range value is flashing, press **SEL** to lock in the selection. The upper limit of the range will not be able to be set to a value that is less than 50°C (100°F) above the lower limit (i.e., there must be at least 50°C or 100°F between limits).
AdcU	Press **SEL** and **UP** to enter the voltage display mode. Be sure a resistance type RTD simulator is attached in place of the RTD. Simulate the upper limit temperature and adjust the span potentiometer on the module such that the voltage is between 4.200 and 4.700 volts on the display. Change the RTD simulator to simulate the lower limit temperature and adjust the zero potentiometer on the module such that the voltage is between 0.200 and 0.800 volts. Repeat the above process until the upper and lower voltages are within the stated limits. When completed, be sure the simulator is simulating the upper limit temperature. Press the **SEL** key to lock in the upper limit voltage.
rn9L	Press **SEL** and **UP** to change the temperature range lower limit. When **SEL** and **UP** are pressed, the lower limit will begin flashing. Pressing the **UP** or **DOWN** keys will change the lower limit to another value. When the correct range value is flashing, press **SEL** to lock in the selection. The lower limit of the range will not be able to be set to a value that is greater than 50°C (100 °F) below the upper limit (i.e., there must be at least 50°C or 100°F between limits).
AdcL	Press **SEL** and **UP** to enter the voltage display mode. Be sure a resistance type RTD simulator is attached in place of the RTD. Enter the lower limit temperature (either 0°C or 32°F) in the simulator. The resulting voltage reading will be displayed. *Do NOT adjust either the zero or span potentiometers in this step.* Press the **SEL** key to lock in the lower limit voltage. Note that zero adjustments are made in the procedure for the upper limit. This step is just used to record the lower limit voltage.

6.4.9 KEY SEQUENCES FOR CALIBRATION OF OPTIONAL TWO-CHANNEL RTD PROCESS MODULE

Key sequences for calibrating two-channel RTD process #1 input signal

This procedure should be followed only if a two channel RTD process module is used. This step calibrates both the lower and upper process signals for input #1.

Press **DN** to select the lower input parameter **Pr1L**.

Press **SEL + UP** to begin calibrating the parameter.

1) Connect a calibrated RTD simulator to process input #1.
2) Select an RTD resistance that corresponds to -100°C. The voltage corresponding to the resistance is shown on the display as **‘X.XX’**.
3) Press the **UP** switch to record the lower temperature value.
4) Select an RTD resistance that corresponds to +350°C. The display will show a differential voltage as **‘dX.XX’**. The **d** indicates that the displayed value is the difference between the actual current voltage and the recorded lower temperature voltage.
5) Adjust the span potentiometer for a differential voltage reading of ‘**d4.60**’ volts.
6) Repeat steps 2 - 5 until the voltage difference reads ‘**d4.60**’ without further adjustments.

Press **SEL** to accept the value shown and return to the calibration menu.

Key sequences for calibrating two-channel RTD process #2 input signal

This procedure should be followed only if a two channel RTD process module is used. This step calibrates both the lower and upper process signals for input #2. Follow these steps only if an RTD is connected to the process #2 input.

Press **DN** to select the lower input parameter **Pr2L**

Press **SEL + UP** to begin calibrating the parameter.

1) Connect a calibrated RTD simulator to process input #2.
2) Select an RTD resistance that corresponds to -100°C. The voltage corresponding to the resistance is shown on the display as **‘X.XX’**.
3) Press the UP switch to record the lower temperature value.
4) Select an RTD resistance that corresponds to +350°C. The display will show a differential voltage as **‘dX.XX’**. The d indicates that the displayed value is the difference between the actual current voltage and the recorded lower temperature voltage.
5) Adjust the span potentiometer for a differential voltage reading of **‘d4.60’** volts.
6) Repeat steps 2 - 5 until the voltage difference reads **‘d4.60’** without further adjustments.

Press **SEL** to accept the value shown and return to the calibration menu.

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6.4.10 KEY SEQUENCE FOR CALIBRATING THERMOCOUPLE PROCESS MODULE

With this type of process module, the connected thermocouple develops a voltage representing the temperature of the process. Thermocouples can cover a very wide temperature range. The thermocouple module however allows a narrower temperature range to be used. This is useful for applications that need higher resolution and do not need a wide range.

The purpose of this procedure is to specify the thermocouple type, temperature units, temperature range, and to record the actual voltage values at the lower and upper process limits. This procedure involves adjusting components on the thermocouple module. This procedure is entered by selecting either the **Pr1L** or **Pr1U** parameter for calibration. When either of these parameters are selected for calibration, the controller starts the following calibration sequence. At any time in the menu, the user can press the **SEL** key to return to the calibration menu.

NOTE: For greatest accuracy, the thermocouple simulator should be connected to the controller input module, and the simulator and the controller board should be turned on and allowed to temperature stabilize for at least 15 minutes prior to calibrating. The minimum allowable temperature span is 100°C (212°F).

Any one step in the calibration procedure can be performed without performing the others. However, it is recommended to perform all the calibration steps if any one item is changed.

Calibrating the thermocouple module circuitry involves adjusting the gain potentiometer on the module to achieve the desired temperature range. When adjustments have been properly completed, the calibration routine will use the calibrated analog voltages to create a linearization table.

The table on opposite shows the calibration steps and the procedures required to complete the steps. It is recommended to perform all the calibration steps if any one item is changed.

Press the **DN** key until the **Pr1L** parameter appears. On that display, press the **SEL** and **UP** keys simultaneously to enter the thermocouple calibration menus shown opposite.

On the menus on opposite, use the **DN** key to move from one parameter to the next one in sequence. When calibration is completed, press and hold the **SEL** key for 3 seconds to return to the main Calibration Mode menu (the **Pr1L** parameter). Release and then press the **SEL** key again for 3 seconds to return to the Run Mode.

NOTE: When either the thermocouple type or units are changed, the upper range limit will be changed to the maximum upper limit as described earlier. The lower range limit is always fixed at 0°C or 32°F.

6.4.11 THERMOCOUPLE TYPES AND TEMPERATURE RANGES

For a controller with a thermocouple module, different types of thermocouples can be used to measure process temperatures. Some types have wider available temperature ranges than others. The maximum range available for the type used is shown in the table below.

A narrower range can be specified in the Calibration Mode. Narrowing the range will increase the resolution of the process temperature measurement and will allow for better setpoint control.

THERMOCOUPLE TYPE	RANGE LOWER LIMIT	RANGE LOWER LIMIT
E	0°C / 32°F	350°C / 650°F
J	0°C / 32°F	500°C / 900°F
K	0°C / 32°F	550°C / 999°F
T	0°C / 32°F	400°C / 750°F

STEP DISPLAY	PROCEDURE
tYPE	Press **SEL** and **UP** to change the thermocouple type. When **SEL** and **UP** are pressed, the type will begin flashing. Pressing the **UP** or **DOWN** keys will change the display to another type. When the correct value is flashing, press **SEL** to lock in the selection.
UniT	Press **SEL** and **UP** to change the temperature units. When **SEL** and **UP** are pressed, the units will begin flashing. Pressing the **UP** or **DOWN** keys will change the units between degrees Fahrenheit and Celsius. When the correct units are flashing, press **SEL** to lock in the selection.
Rn9U	Press **SEL** and **UP** to change the temperature range upper limit. When **SEL** and **UP** are pressed, the upper limit will begin flashing. Pressing the **UP** or **DOWN** keys will change the upper limit to another value. When the correct range value is flashing, press **SEL** to lock in the selection. The upper limit of the range will not be able to be set below 100°C or 212°F.
AdcU	Press **SEL** and **UP** to enter the voltage display mode. Be sure a thermocouple simulator is attached in place of the thermocouple. Simulate the upper limit temperature and adjust the gain potentiometer on the module such that the voltage is between 4.200 and 4.700 volts on the display. Press the **SEL** key to lock in the upper limit voltage.
Rn9U	The value given with this display is the lower temperature limit and is shown to remind the technician of the temperature to use for the simulator. This value is fixed and not programmable.
AdcL	Press **SEL** and **UP** to enter the voltage display mode. Be sure a thermocouple simulator is attached in place of the thermocouple. Enter the lower limit temperature (either 0°C or 32°F) in the simulator. The resulting voltage reading will be displayed. *Do NOT adjust the gain potentiometer in this step.* Press the **SEL** key to lock in the lower limit voltage.

6.4.12 KEY SEQUENCES FOR CALIBRATING THE CYCLE TIME

Press **DN** to select the cycle time parameter **Cyt**
Press **SEL** + **UP** to perform the cycle time measurement.

6.5 PROGRAM MODE

Press **SEL** key for 3 seconds to enter Program Mode **Prog** from Run Mode. A security code may be required for entry to the Program Mode. If one is required, it is checked and entered using the instructions below and for editing a numeric value as described on Page 25 Section 6.5.2.

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Prog will be displayed for 2 seconds and the security code will be checked. If the required security code is not zero (0000), the display will begin alternating between **CodE** and **0000**. If the required security code is zero, it will not need to be entered, i.e., it will be bypassed and display will automatically flash **Addr**. You can now select functions as found in the table below.

Enter the security code, if necessary, as follows. (If the code is forgotten, the special number 4800 can be used to gain entry).

Quick tap **SEL** key once. First 0 will flash. Quick tap **UP** key until you reach code number. Quick tap the **DN** key once. The second 0 will flash. Quick tap the **UP** key until the next code number is reached. Continue this procedure as needed for the remaining code numbers. Quick tap **SEL** to accept code.

Press **SEL** for 2 seconds to return to the Run Mode.

6.5.1 PROGRAM MODE MENU

DISPLAY	DESCRIPTION	MIN. VALUE	MAX. VALUE
CodE	Security code for access to program, calibration and manual setpoint modes.	0000	9999
Addr	Communications unit address	1	255
PtEr	Proportional control term.	0000	9999
ItEr	Integral control term	000	999
DtEr	Derivative control term	0000	8000
onH	Motor cycle interval	1.0 sec	999.9 sec
FILt	Process signal filter time	0.8 sec	60.0 sec
bLt	Gearbox backlash time	0 ms	9999 ms
tort	Gear torque time	0 ms	9999 ms
dEbA	Controller dead band	0.1	20.0
ACt	Controller action – RISE or FALL		
CYCr	Cycle Interval Reset – ON or OFF		
FPOS	Process or Setpoint invalid reading action – HOLD, NONE, or a position value	.0.0%	100.0%
SAcT	Invalid feedback pot reading action – GOC (go clockwise), GOCC (go counter-clockwise), HOLD, or NONE		
YA	Lower shaft position limit (must be less than or equal to YE)	0.0%	100.0%
YE	Upper shaft position limit (must be greater than YA)	0.0%	100.0%
br	Brake ON time	0.10 sec	0.99 sec
CYCn	Run time cycle count (in thousands of cycles)		
AHI	Over-travel Alarm	0.0%	100.0%
ALo	Under-travel Alarm	0.0%	100.0%
PrLo	Process Low Alarm Value	PENL	PENU
PrHI	Process High Alarm Value	PENL	PENU
bAUd	Communications Baud Rate	1200 bps	38.4 Kbps
Pr59	Process Signal Selection – PR1, PR2, or BOTH		
PEnL	Process Engineering Units Range (Lower)	-999	999
PEnU	Process Engineering Units Range (Upper)	-999	999
SEnL	Setpoint Engineering Units Range (Lower)	-999	999
SEnU	Setpoint Engineering Units Range (Upper)	-999	999
PrSt	Restore Default Parameters (YES or NO		

NOTE: A decimal point may be entered when entering **PEnL** and **PEnU** values, if the controlled range falls between -99.9 and 99.9. This has the effect of improving resolution for small process ranges (i.e., 0.0 to 10.0 GPM).
See Controller specification on floppy disk for more detail.

6.5.2 INSTRUCTIONS FOR EDITING PARAMETERS

Press **UP** or **DN** to select the desired parameter.

Press **SEL** to begin editing.

Numeric Parameters

1) Press **DN** to select the digit to be edited. The selected digit will blink.
2) Press **UP** to increment the digit value as many times as necessary.
3) Press **SEL** to store the parameter value and return to menu.

Selection List Parameters

1) Press **UP** or **DN** to select the desired choice. The choice will blink.
2) Press **SEL** to store the parameter value and return to menu.

Combination Parameters

Some parameters may have both numeric and selection list possibilities for their values. If the present value of the parameter is numeric, the leftmost digit of the display will be blinking; if the present value is a selection list choice, the entire choice name will be blinking.

1) Press **DN** will advance through the digits or will enter and leave selection list editing.
2) Pressing **UP** will increment a digit or will advance to the next available choice in the selection list.
3) Press **SEL** to store the parameter value and return to menu.

Cycle Count Parameter

The cycle count parameter may only be cleared. The cycle count will begin flashing.

Press **DN** for 4 seconds to clear the cycle count and return to menu.

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6.5.3 DEFAULT (FACTORY) VALUES FOR PROCESS CONTROL

When parameters are defaulted in the Program Mode, they are set as described below. The table below shows values for the 4-20 mA (analogue) process module. If another process module is used, the other columns show exceptions to the default values (if any) Use the **PrSt** function to set default values.

PARAMETER	ANALOGUE MODULE	THERMOCOUPLE MODULE	RTD MODULE
Communications addr	1		
Proportional term	1,000		
Integral term	60		
Derivative term	10		
Motor cycle interval	1.5 seconds		
Filter time	0.8 seconds		
Backlash time	600 ms		
Gear torque time	0 ms		
Dead band	0.5 units		
Controller action	RISE		
Cycle interval reset	ON		
Process low alarm	0	(see Note 1)	-100°C
Process high alarm	100	(see Note 1)	+350°C
Invalid process reading action	NONE (ignore)		
Invalid shaft reading action	NONE (ignore)		
Lower (Ya) limit	0%		
Upper (Ye) limit	100 %		
Brake time	0.25 seconds		
Lower travel alarm	0%		
Upper travel alarm	100%		
Communications baud rate	38,400 bps		
Process signal selection	Pr1		
Process lower engineering units	0	(see Note 1)	-100C
Process upper engineering units	100	(see Note 1)	+350°C
Setpoint lower engineering units	0	(see Note 1)	-100°C
Setpoint upper engineering units	100	(see Note 1)	+350°C

NOTE 1: For the thermocouple module, default values depend on the type of thermocouple used. The maximum range will be used for the thermocouple type selected. See table on Page 24 for a list of maximum range values.

6.6 MANUAL SETPOINT MODE

Press **SEL** + **UP** keys for 3 seconds to enter Manual Setpoint Mode from Run Mode. **LSEt**

A security code may be required for entry to the Manual Setpoint Mode. If one is required, it is entered using the instructions for editing a numeric value as described in Program Mode.

Press **SEL** key for 2 seconds to return to the Run Mode.

6.6.1 CHANGING THE MANUAL SETPOINT VALUE

Press **SEL** to enter the edit mode. Edit the value of the setpoint as a Combination Parameter as described in the Program Mode.

6.6.2 DISABLING MANUAL SETPOINT

Press **UP** + **DN** while the display is alternating to turn off the manual setpoint feature. The display will show **OFF**.

6.7 MANUAL POSITION MODE

Press **SEL** + **DN** + **UP** keys for 3 seconds to enter Manual Position Mode from Run Mode. **LPOS**

A security code may be required for entry to the Manual Position Mode. If one is required, it is entered using the instructions for editing a numeric value as described in Program Mode.

Press **SEL** key for 2 seconds to return to the Run Mode.

6.7.1 SETTING POSITION

Press **UP** or **DN** to rotate the controller shaft either counter-clockwise or clockwise respectively. The shaft will continue to move as long as the key is held down and a limit switch has not tripped.

During the Manual Position Mode, a host controller connected on the serial data link has no control of either the setpoint or the actuator / valve position. Also in this mode, the setpoint input is ignored.

6.7.2 AUTO-TUNING

Press **SEL** + **DN** to enter the Auto Tune mode. The display will show **Atun** for 3 seconds. At this and at any point in the auto-tuning procedure, the user can press the **SEL** key for 3 seconds to exit auto-tuning and return to the Manual Position Mode.

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DISPLAY	DESCRIPTION	MIN. VALUE	MAX. VALUE
StEP	The amount of valve position step change desired when running Auto-Tune	1%	40%
FLcT	The amount of fluctuation in the signal value while it is monitored for 60 seconds		
StP1	The elapsed time since StP1 was started		30 minutes
StP2	The elapsed time since StP2 was started		30 minutes
StP3	The elapsed time since StP3 was started		30 minutes
PtEr	The value of the suggested Proportional Term calculated by the Auto-Tune Algorithm	0000	9999
ItEr	The value of the suggested Integral Term calculated by the Auto-Tune Algorithm	000	999
dtEr	The value of the suggested Derivative Term calculated by the Auto-Tune Algorithm	0000	8000
CYCt	The value of the suggested Cycle Interval calculated by the Auto-Tune Algorithm	1.0 second	999.9 seconds
ALr	Any alarm except the setpoint alarm will cause Auto-Tune to halt and the actuator shaft will return to its original position.		
Erto	A 30 minute timeout error. Will cause Auto-Tune to abort and the actuator shaft to return to original position		

6.8 POSITIONER MODE

The controller has a unique feature, which allows the application of a 24 VDC signal to the controller board to switch it to a basic positioner mode. The board then uses the analog 4-20 mA setpoint signal as the positioning signal. When the 24 VDC signal is removed, the board switches back to the controller mode. The 24 VDC signal connects to circuit board terminals TB2-5 (positive) and TB2-6 (negative).

6.9 AUTO-TUNING SAFETY CONSIDERATIONS

6.9.1 THINGS TO KNOW BEFORE TUNING

Know how fast and how much the process value changes with a valve position change. The relationship should be graphed.

Determine the valve safe operating range. This can be determined from the step above. This range should provide an adequate change to the process, but should also not allow dangerous situations to occur. The safe operating should be considered when setting the percentage offset term in Auto-Tuning.

The names for the lower and upper position limits respectively are: **yA** and **yE**

If necessary, to insure safe operation of the controller, set shaft position limits using **yA** and **yE**.

6.9.2 SAFETY CONCERNS DURING OPERATION

Determine what should happen in the event of a loss of either the process signal or the setpoint signal. Program the Invalid Reading Action parameter correspondingly. That parameter defaults to an action of **NONE** which means that if it is not changed, no action will be taken (control will attempt to be maintained) if an invalid setpoint or process signal is received.

The name for the Invalid Reading Action parameter is: **FPOS**

6.10 CONTROLLER SETUP

6.10.1 GENERAL SETUP

Read the Safety Considerations section to determine what steps might be necessary to insure a safe control system.

Determine the Engineering Units for the setpoint and process inputs. Program the lower and upper process limits and lower and upper setpoint limits using Program Mode.

Program alarm limits if they are used.

6.10.2 TUNING THE CONTROLLER AUTOMATICALLY (open-loop tuning)

Be sure the controller is properly set up as described above. Be sure to know the safe operating range of the valve.

Enter the Manual Position Mode and set a starting valve position.

Enter the Auto-Tune Mode and establish the offset percentage for valve movement.

Run the Auto-Tune procedure. If an alarm occurs, note the alarm condition, exit the Auto-Tune Mode and take appropriate action to insure a safe condition. If Auto-Tune completes, view the computed control terms and decide whether to install them or reject them.

If there are no alarm conditions, return to the Run Mode and observe controller operation. If more tuning is desired, consider the closed-loop tuning described below. Alternately, individual control parameters can be modified in the Program Mode.

6.10.3 TUNING THE CONTROLLER MANUALLY

Manual tuning involves making changes to the setpoint and observing the behavior of the process. Observations should be recorded and some type of recording device (e.g., a strip chart recorder) is highly recommended.

Be sure the controller is operating in a safe and relatively stable manner at or near a typical setpoint.

Enter the Manual Setpoint Mode and make a step change to the setpoint value. The suggested amount of setpoint step change is in the range of 5% to 10%, but should not cause an unsafe condition to occur. Return to the Run Mode.

Measure the lag time. This is the time it takes after the step is made before any change in the process is observable.

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Measure the response of the process. Did it overshoot? If so, by how much? Does it tend to oscillate after a step change? If so, what is the frequency of oscillation? How long does it take the process to reach the new setpoint?

Analyse the results. Based on the requirements for control, determine what control parameters might need changing.

6.10.4 SOME GUIDELINES FOR CONTROL PARAMETERS

The maximum gain possible occurs where the process begins to oscillate about the setpoint.

The recommended proportional gain (the P-term) for stability is one-half or even one-third the maximum gain determined. So, for example, if oscillation begins at a P-term setting of 6000, good stability will be achieved by reducing the setting to 2000 or 3000.

Leave the Integral (I-term) value at 60 unless very high performance operation is required. Refer to the Appendix on floppy disk for fine tuning guidelines.

Leave the Derivative (D-term) value at 10 unless faster response time for high performance systems with short lag times and high proportional gain is required.

Set the Cycle Time to a value greater than or equal to the measured process system lag time. If the cycle time is set to less than the lag time, the valve position might change before the effect of a previous change is detected.

7 TECHNICAL DATA

7.1 ALLOWABLE SUPPLY VOLTAGE RANGE

All voltages +/- 10%
Power consumption (circuit board only) – 2.5 Watts

7.2 ANALOGUE INPUT CIRCUIT SPECIFICATIONS

Maximum tolerated noise level at maximum controller resolution / sensitivity – approx. 3.5 mV (16 microamps).

Resistance Input

DFC-1K – nom. 1000 Ohms
DFC-13 – nom. 135 Ohms

Current Input

DFC-1 – 1 to 5 milliamperes
DFC-4 – 4 to 20 milliamperes
DFC-10 – 10 to 50 milliamperes

Voltage Input

DFC-5V – 0 to 5 VDC
DFC-XV – 0 to 10 VDC

7.3 OUTPUT CIRCUIT SPECIFICATIONS

All Models

Maximum surge current	100 Amps for 1 cycle
Maximum normal starting or in-rush current	10 Amps for 1 second
Maximum stall current	8 Amps for 1 minute
Maximum running current – resistive load 90% Duty cycle	5 Amps
Maximum running current – inductive load 90 % Duty cycle	3 Amps
Maximum peak voltage at load circuit (All 120 & 240 VAC models)	800 VAC
Maximum driver circuit current (All 12 & 24 VDC models)	3 Amps continuous

Alarm output – 100 mA maximum current at 50 volts DC maximum.

7.4 INPUT CIRCUIT LOAD RESISTANCES

1 to 5 milliampere models	Approx. 1000 Ohms
4 to 20 milliampere models	Approx. 220 Ohms
10 to 50 milliampere models	Approx. 100 Ohms
0 to 5 VDC models	Approx. 800 Ohms
0 to 10 VDC models	Approx. 1100 Ohms

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8 TROUBLE-SHOOTING

8.1 GENERAL

The following paragraphs and charts are a trouble-shooting guide for servicing the Controller, should a malfunction occur. If the problem cannot be solved, the unit should be returned to the factory for service.

The first thing to be checked, before proceeding to the troubleshooting guide, is to determine if the malfunction is in the controller, or in the actuator. For AC boards, remove the red and black controller leads from terminals 3 and 4 of the actuator, and connect the AC supply to terminals 1 and 3. Tape the red and black leads with insulation tape. The actuator should rotate CCW until stopped by the CCW limit switch. Then apply power to terminals 1 and 4 to check CW actuation and the CW limit switch terminal 1 (-), terminals 3 & 4 (+).

For 240 VAC digital controller switches do not directly limit travel. Exercise caution not to override limit switches. Operate the unit to its limits in each direction, to assure that the basic actuator is functional.

If the AC actuator does not operate, check wiring from the terminal strip, through the limit switches to the motor and capacitor. For 240 VAC actuator with Digital Controller, check wiring from the terminal strip to the capacitor and to the motor. Check switch continuity. Check for an open motor winding, and check for a shorted capacitor. If the problem in the actuator still cannot be determined, return the unit for service. If the actuator functions properly, then proceed to the trouble-shooting guide.

For DC boards, remove red and black leads coming from motor(s) at terminals 3 & 4. Connect these leads to power supply to check motor(s) operation. If motor(s) run correctly, then proceed to the trouble shooting guide or return unit for service.

To facilitate troubleshooting a Controller, it would be advantageous on resistive input units to connect a potentiometer directly to the Process signal input terminals in place of the standard process input. Use a 150 Ohm or 1000 Ohm potentiometer depending on which model is used. Figure 6 (Page 34) shows a schematic of a simple test unit that can be connected to the input terminals to stimulate the process signal for a milliampere rating.

8.1.1 CAM ADJUSTMENT

The actuator cams should actuate the limit switches 1° to 3° <u>after</u> the actuator stops at either the fully open or fully closed position.

If the actuator is closed at 0 degrees, the limit switch must actuate by the time the actuator is at the minus 1 to 3 degree position. Similarly, at the open or 90 degree position, the limit switch must actuate by the time the actuator is at the 91 to 93 degree position.

See NOTE in Section 8.1.3 (opposite).

8.1.2 CHECK FUSE F1

Check fuse F1 to see if it has blown. If it has, replace it with Littlefuse PICO II very fast acting fuse rated at 62 mA. (Newark part number 94F2146).For DC boards, also check fuse F2 to see if it has blown. If it has, replace it with a 1¼", 250 volt, 3 amp fuse, available through any electrical supplier.

IMPORTANT: To check fuse F1 - remove it from circuit and test with ohmmeter. Resistance should be about 6 Ohms.

NOTE: If fuse F1 has blown, excessive voltage (possibly 120 VAC) was applied to the signal input circuit. If so, correct this condition before changing fuse.
See Page 13 Section 5.

8.1.3 FOR AC BOARDS, CHECK BASIC ACTUATOR FOR PROPER OPERATION USING THE CORRECT AC VOLTAGE.

a). Remove red and black leads coming from AC circuit board at terminals 3 & 4 (if already installed). Tape stripped ends of these wires.

b). For AC boards, alternately energize, with the appropriate AC voltage, terminals 1 & 3 and 1 & 4. The actuator should move clockwise when energizing terminals 1 & 4, stopping only at the clockwise limit switch. The actuator should move counter-clockwise when energizing terminals 1 & 3, stopping only at the counter-clockwise limit switch.

NOTE: For 240 VAC Digital Controller only, limit switches do not directly control motor. Therefore, the actuator will not stop when the limit switches trip. Use care not to drive the actuator past its normal limits. Run the actuator to its limits in each direction, to assure proper operation of the actuator.

If the circuit board's light emitting diodes (L.E.D.'s) blink or seem to continuously glow, electrical noise is interfering with the Controller's Process input signal or the setpoint input signal. (Always use shielded cable for both the process signal and the setpoint signal coming to the Digital Controller board. Ground the shield at only one end.) Adjust Digital Controller as necessary. See Page 12 Section 4.6.

8.1.5 THE FOLLOWING INFORMATION IS PROVIDED IF IT BECOMES NECESSARY TO REPLACE THE CIRCUIT BOARD.

a) Turn off the power supply and disconnect the circuit board wires from the terminal strip. Disconnect the pot wires at TB1 and any wires at TB-2.

b) Remove circuit board mounting screws, nylon washers, circuit board and insulator board with rubber grommets from the brackets.

c) Install new circuit board onto the brackets. See Page 6 Section 3.

NOTE: Size 23 actuators use a spacer in place of a grommet at the transformer support bracket.

d) Make electrical connections per the appropriate wiring diagrams (See Page 8 Section 4). Route the 3 feedback potentiometer wires through the hole in the board near TB-1 (Page 9 Figure 1).

e) Calibrate the new circuit board. See Page 16 Section 6.4.

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8.2 SYMPTOM TABLE

	SYMPTOM	GUIDELINES TO FOLLOW
A	Actuator will not operate in either direction [no sound from motor(s)].	8.3 - A, B, C, D, E, F, G, K
B	Actuator will not operate in either direction [humming or buzzing sound from motor(s)].	8.3 - B, C, D, E, F, J, K, L, M
C	Actuator slowly moves in one direction on its own.	8.3 - D
D	Actuator runs normally for 7-8° while coming off limit switch, then slows down or stops [motor(s) hum or buzz].	8.3 - D, Q
E	Actuator oscillates intermittently or upon reaching a new position.	8.3 - B, H, N
F	Actuator runs slowly in one or both directions, but otherwise operates normally.	8.3 - B, D, J, K, L, M
G	Actuator works intermittently.	8.3 - B, K, M
H	Actuator runs normally in one direction but will not operate in the other direction [no hum or buzz from motor(s)].	8.3 - B, D, G
J	Actuator will not move valve after a stop when signaled to travel in same direction as previous command.	8.3 - P

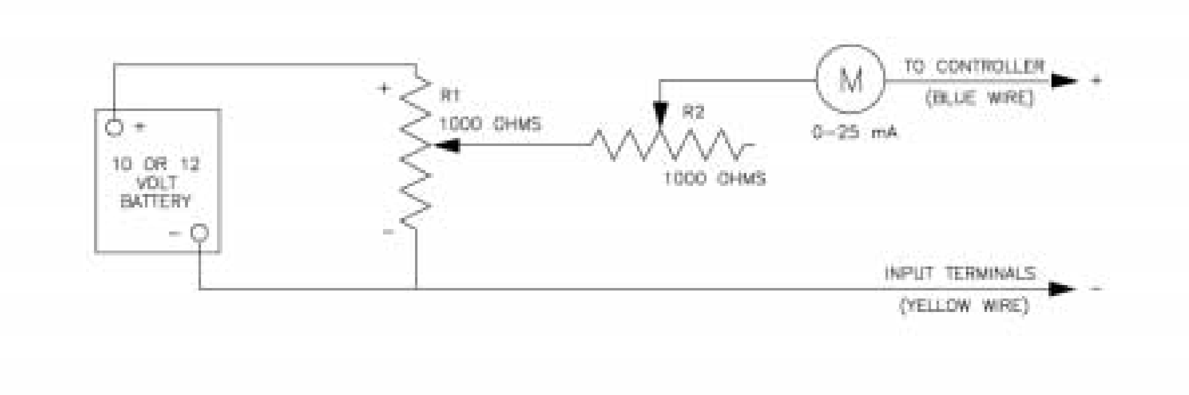

Figure 6

Simple 4-20 mA Supply Circuit

Test Unit for Milliampere Setpoint Input Controller - Set R1 all the way toward the plus end. Adjust R2 for a 20 mA reading. Varying R1 will now provide input signals between 4 and 20 milliamperes.

8.3 TROUBLE-SHOOTING CHART

Use the following trouble-shooting guidelines to isolate problems/bad components.

	CHECK	ACTION	NOTES AND CAUTIONS
A	Check for proper AC/DC power to actuator and circuit board. See Figures 3 & 4	Correct as necessary	Correct as necessary
B	With power off, check for broken wires and/or loose connections.	Repair broken wires and tighten loose connections.	
C	With power off, check to see if fuse F1 is blown (For DC boards, See Section 8.1.2).	Remove F1 from socket pins and check for continuity through fuse with an ohm meter. If F1 is bad, replace it with a new fuse.	Before restoring power, try to determine what caused F1 to blow and correct problem. See Section 8.1.2.
D	Check operation of basic actuator. See Section 8.1.	See Section 8.1	This check will isolate the problem to either the actuator or the circuit board.
E	Check for proper range of setpoint & process input signals.	Use ammeter, voltmeter or ohm meter to verify input signal range.	See models listed at beginning of IOM for ranges. 4-20 mA is most common.
F	With power off, check calibration of feedback potentiometer.	With shaft in full CW position, resistance between purple and wht/blk wires from pot should be 80 to 90 Ohms. Take reading with the power off. Recalibrate if necessary. See Section 6.4	When trying to move the valve manually with the clutch disengaged, be certain that the wrench fits properly on the flats of the actuator shaft. Improper fit can cause shaft damage with consequent damage to cover bearing surface. Stay within the preset quadrant of operation as indicated on actuator cover.
G	Check to see that varying the process signal above & below the Setpoint value. causes the light emitting diodes (LEDs) to turn on and off individually.	If LEDs do not turn on and off, replace board.	The turning on and off of the LEDs is indicative that the input side of the circuit board is OK.
H	Check the operation of the Controller with a portable, battery operated Process signal source if possible or some other appropriate process signal simulator.	If intermittent or jittery operation stops, it is indicative of a noisy online signal input. To avoid damaging the actuator, it is necessary to “clean up” the signal. Also, follow the shielding guidelines. See Section 4.	Increasing the deadband may help to alleviate the problem.
J	Check the motor run capacitor for a short, excessively high leakage and low capacitance. Use a capacitance meter to check. (AC boards only)	Replace as necessary.	Disconnect all leads from capacitor terminals (power off) prior to testing. Do not exceed rated voltage of capacitor. Make certain that capacitor is discharged before reconnecting.

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	CHECK	ACTION	NOTES AND CAUTIONS
K	Check temperature of motor(s). One AC motor has a thermal cutout switch built in that opens at about 98.9°C (winding temperature). If the thermal cutout has opened, both motors are de-energised until the thermal switch resets (20-23 75 sizes).	Allow the motor(s) to cool so that the thermal switch can reset. Normally the thermal switch will not open unless the motor's rated duty cycle is exceeded and/or the ambient temperature is very high. Correct the problem.	Duty cycle is specified at an ambient temperature of 21.1°C, 60 HZ.
L	Check the operating torque of the valve. If necessary, remove the actuator from the valve. Measure valve torque with an accurate torque wrench. Check torque under actual operating conditions if possible.	If operating torque of valve exceeds the specified torque for the seats used and the DP across the valve, determine cause and correct. If torque falls within normal range, it is possible that the actuator is undersized.	If the actuator is removed from a 3piece valve that requires the body bolts to also be removed, the valve body bolts must be retorqued to spec. before checking valve torque. See Valve IOM.
M	Check ambient temperature.	Actuator duty cycles are specified at an ambient temperature of 21.1°C.	Higher ambient derates duty cycle.
N	Check to see that mechanical brake is operating correctly.	Replace defective mechanical brake. If one was never installed, order a kit and install it in actuator.	All 2" CPT valves with Controller boards in actuator must have mechanical brake installed to prevent oscillation.
P	Check to see if actuator can move a high torque valve from a stop under load when moving in the same direction as last command (mechanical brake does not allow motor(s) to unwind).	If motor(s) cannot start, go to next larger size actuator.	
Q	Check to see which direction of travel causes problem. If actuator is coming off open limit switch (traveling CW) when it slows down or stops, then either Q1 or U1 is bad. If actuator is coming off closed limit switch (traveling CCW), then either Q2 or U2 is bad (AC boards only).	Replace circuit board.	

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